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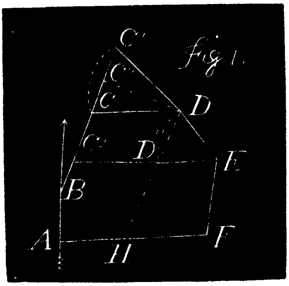
ON SUPPLYING OMISSIONS IN LAND SURVEYING.

BY P. H. PHILBRICK, PROF. OF CIVIL ENGINEERING, IOWA STATE UNIV.

In our standard works on Land Surveying we are told that: "Any two omissions in a *closed* survey whether of the length, or of the direction, or of both, of one or more of the sides bounding the area surveyed, can always be supplied by a suitable application of the principle of Latitudes and Departures."

Let us proceed to examine the truthfulness of the statement.

Case I. When the length of one side and the bearing of another are wanting.



(*a*). Let the deficient sides adjoin each other.

Let $ABCDEF$ (Fig. 1) represent the case; in which the *length* of BC and the *bearing* of DC are unknown.

Solution. With D as a center and the known length of DC as a radius describe an arc. This arc will in general intersect the indefinite line BC in two points (C & C') either one of which may be taken, consistently with the data, as the missing corner, thus giving the two figures $ABCDEF$ and $ABC'DEF$ either one of which may be considered as the field surveyed.

(*b*). Let the deficient sides be separated from each other.

Suppose the length of BC and the bearing of ED unknown.

Solution. Draw DH parallel to BC. With E as a center and the known length of ED as radius describe an arc which arc will generally intersect DH in two points D and D' from which we draw DC and $D'C''$ giving the two figures $ABCDEF$ and $ABC''D'EF$, the latter of which complies with all the data of the problem equally well with the first which by hypothesis represents the tract surveyed.

In case the length of the side whose *bearing* is unknown is equal to the length of the perpendicular upon the side whose *length* is unknown; then whether the deficient sides are separated or not the two solutions unite in one. Thus if DC is equal to the perpendicular DC''' upon BC the points C and C' coincide in C''', and the two figures $ABCDEF$ and $ABC'DEF$ become identical being represented by $ABC'''DEF$.

If more than one *known* side intervene between the deficient sides a similar construction will nevertheless suffice.

Case II. When the lengths of two sides are wanting.

(*a*). The deficient sides adjoin.

In Fig. 1 let the lengths of BC and DC be wanting. From B and D with the given bearings of BC and DC we must run the lines BC and DC to their intersection C, thus there is but one solution in this case.

(*b*). The deficient sides are separated.

Let AB and DC (Fig. 2) running from A and D in known directions, be the sides whose lengths are unknown, B and C representing the undetermined corners.

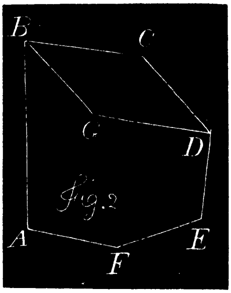


Fig. 2

From D draw DG with the length and bearing of the side which lies between AB and DC. Draw GB parallel to DC to intersect AB in B, and BC parallel to GD to intersect DC in C. $ABCDEF$ represents the tract surveyed.

If however AB and DC are parallel G is on AB or its prolongation; for if not, GB and AB, which according to the present hypothesis are parallel, would not intersect and consequently the survey would not close. Since G then, lies upon AB, and GB and AB are *parallel* they must coincide and therefore any point upon AB may be taken as their intersection from which a line drawn parallel to GD to intersect DC will close the survey. Thus there are an infinite number of solutions in this case as is illustrated in fig. 3. If more than one side lie between the deficient sides a similar construction will still suffice.

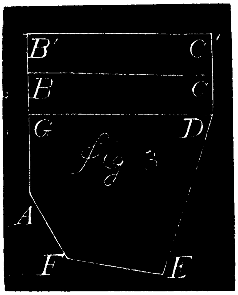


Fig 3

Case III. When the bearing of two sides is wanting.

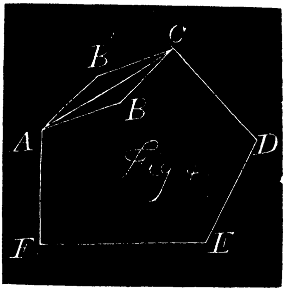
(*a*). Let the deficient sides adjoin each other.(fig. 4)

Let C, D, E, F and A represent the known corners. The distances of the corner B from A and C being known but not its bearings.

Solution. With A and C as centers and radii equal to AB and CB respectively describe arcs. These arcs will always intersect in two points B and B' giving the two figures $ABCDEF$ and $AB'CDEF$, either of which answers to all the conditions of the problem and therefore may be taken to represent the tract surveyed.

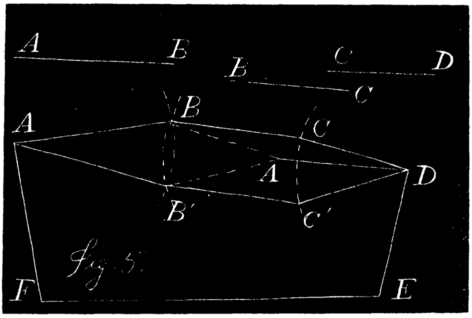
The arcs described with the centers A and C must intersect since the survey must close, and they must intersect in two points for otherwise AB and BC would represent the same line.

(*b*). Let the deficient sides be separated from each other.



Let A, F, E and D (Fig. 5) represent the fixed corners; and let AB and CD represent the length of the sides of which the bearings are wanting, ands BC represent the length and bearing of the intermediate side.

Solution. With A and D as centers and radii equal respectively to AB and DC, describe arcs BB' and CC'. Draw DH equal and parallel to CB and with H as a center and radius equal also to DC describe an arc BB' which will in general intersect the former arc BB' in two points B and B'. From B and B' draw BC and $B'C'$ each parallel to DH and intersecting the arc CC' in the points C and C'. Then either $ABCDEF$ or $AB'C'DEF$ will represent the survey.



If B and B' coincide there is but one solution. If the different sides are separated by more than one side a similar construction to the above would suffice.

Omitting therefore the case in which the lengths *only* of two adjoining sides are wanting, since the fact that there can be but one position for the missing corner is axiomatic; and, for the same reason, omitting the case in which the deficiencies pertain to one side; we find three cases in which there are usually two solutions though there may be but one; one case in which there is usually but one solution though there may be an infinite number of solutions; and another case in which there are always two solutions.

Thus we see that the proposition quoted at the head of this article is missleading–in fact the truth is not in it at all–and *that* surveyor therefore who pays any regard to it will be led astray and his work vitiated.

[It freequently occurs that a formula which represents the complete solution of a question cannot be definitely interpreted from the *data* used in the formula. The additional information required is however, generally, readily obtained. The Surveyor should always, when practicable, close his survey by actual measurment, and the "principle of Latitudes and Departures" used in his calculation will then enable him to discover and eliminate his principal errors. If however it is impracticable to obtain the exact bearing of one or two of his lines, their *approximate* bearing should be noted, which will be sufficient generally to obviate the ambiguity discussed above.—Ed.]